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A DECISION SUPPORT SYSTEM FOR REAL ESTATE INVESTMENT CHOICE[1].

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Abstract
The evaluation of real estate assets is currently one of the main focal points addressed by territorial marketing strategies with a view to developing high-performing – or competitive – cities. Given the complexity of driving forces that determine the behaviour of actors in a real estate market, it is necessary to identify a priori the factors that determine the competitive capacity of a city to attract investments to this market. Therefore, we need a measureable decision support system that takes into account the key factors that determine the 'attractiveness' of such investments in a competitive context. In the present paper we aim to design an integrated complex evaluation model that is able to map out and encapsulate the multidimensional spectrum of factors that shape the attractiveness of alternative real estate options. From an analytical perspective, we will select relevant attributes for the specification of a random utility model capable of simulating the behaviour of market operators when they are faced with a choice between alternative real estate investment sites. Specifically, a multidimensional assessment model in a decision-making context is developed in which the choice between alternative discrete investments takes place under conditions of uncertainty. This model serves two purposes: (i) it responds to the need to define the 'attractiveness' of an area with respect to real estate investments, and (ii) it explains what characteristics of the investment site affect the market operators' choices. The conceptual-methodological approach is then illustrated by an application of the model to a real-world case study of investment choice in the residential sector in the city of Naples.

Keywords: housing markets, investment choices, Stated Preference experiment, Analytic Hierarchy Process (AHP)

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[1] The division of tasks among the five authors who cooperated to produce this paper was as follows: Vincenzo Del Giudice was responsible for coordinating the whole study and for the Introduction; Francesca Torrieri and Pierfrancesco De Paola contributed equally to Sections 2, 3 and 4, while Francesca Pagliara was in change of the Social Preference experiment and presented its results in Section 3.3. Peter Nijkamp was particularly engaged in the methodological part.

1. Introduction

The present paper aims to assess how investment choices of different agents operating in the real estate market are influenced by a multidimensional choice set comprising environmental and social attributes that vary across alternative territorial contexts. In general, residential location choice behaviour has been widely addressed in the academic literature, with particular reference to the impact that the transportation system and location attributes in an area have on the decision context. Up till now, little attention has been paid to the impact of environmental attributes, especially those related to the quality of places, in the decision-making process concerning investments in a real estate market.

Studies on residential location traditionally fall into two main groups: (i) the market approach, associated with economic scholars such as Alonso (1964); and (ii) the non-market approach, associated with sociologists such as Rex and Moore (1967). In terms of the explanation of broader social science phenomena such as housing dispersion, gentrification and abandonment, Hoang and Waley (2000) have highlighted the importance of the non-market approach; they argue that housing status and dwelling quality appear to be more important determinants of existing patterns of residential location than access-space trade-off. However, despite the solid theoretical underpinning of their work, it may be viewed as supplementing rather than replacing the market approach, given that in much empirical work housing status was defined partly in terms of distance from the city centre and access to the street (Kim et al., 2005).

In the present paper, we will present a real estate choice model mainly oriented towards those qualitative attributes – relative to the dwelling and territorial context – that influence this choice. In particular, our study aims to identify which of the attributes that characterize each investment destination, predominantly influence the behaviour of different agents. The model proposed considers that choices in the real estate market are characterized by many uncertain factors determined by the non-typical conditions and a high complexity of the market in question (Simonotti, 1997), both from the demand and the supply side. In this context, we will develop a measurable 'attractiveness' function for each territory. The metropolitan area of Naples is next used as a case study to test our analysis framework.

The paper is organized as follows: In Section 2, we present an overview of the issues concerning residential location choice behaviour with particular reference to the methodological approach adopted by us. Next, after an introduction, in Subsections 3.2 and 3.3, we present the results of a survey designed to select the relevant attributes to be included in the model, assessed on the basis of a questionnaire structured according to the Analytic Hierarchy Process AHP (Saaty, 2001). In Section 3.4, a Stated Preference survey (SP) is presented for the assessment of different alternative investment choice locations characterized by various attributes. The applied choice experiment was structured according to the guidelines of the "*Catalogue of Computer Programs for the Design and Analysis of Orthogonal Symmetric and Asymmetric Fractional Factorial Experiments*" (Kocur et al., 1982). The conclusions and further research perspectives follow in Section 4.

2. Residential Location Choice Model: Issues and Approaches

The proper specification of a residential location choice model calls for an understanding of the housing market and of the actors operating in it. Indeed, from an economic point of view, the multi-faceted housing market conditions guide investment choices for the savers and businesses that operate there.

Standard economic theory assumes, in general, a hypothetical perfectly operating market that provides an efficient allocation of resources. This market is based on a series of assumptions regarding the behaviour of buyers and sellers, as well as the characteristics of the products. The real-world housing market however, represents a typical example of a real market where most of the hypotheses about perfectly competitive markets are violated. In fact, it is characterized by a series of specific elements that determine the heterogeneous nature of this market (Simonotti, 1997):

i) the limited number of buyers and sellers;
ii) the specific characteristics of the property (e.g., starting position, lumpiness);
iii) the existence of barriers to entry from the demand side (for the level of spending and solvency) and the supply side (for the behaviour of the sellers);
iv) the imperfect and incomplete knowledge of the specific conditions determining real prices, terms of payment, and the amount offered;
v) the presence of administrative intervention and public intervention;
vi) the segmentation of the market into sub-markets.

These factors introduce intransparant elements of uncertainty and randomness in the choice behaviour of actors who operate in a real estate market, while taking into account the heterogeneity of choice behaviour, the lack of comprehensive information on alternatives of choice, and the presence of unobserved variables (McFadden and Cox, 2005). Actually, the household residential location choice is a complex function of a wide range of housing and location attributes. The relative importance of these attributes will vary across different types of households. In reality, consumers differ substantially in their tastes for housing, and may also display *bounded rationality*, with the consequence that a great variety of responses may result from the presentation of the same well-defined alternatives to each consumer in a population. Further, the housing market may be slow in adjusting to equilibrium, making arbitrage a profitable activity. Clearly, due insight into consumer tastes, responses and behaviour in the area of housing location decisions – or, more generally, real estate decisions – is needed (see also McFadden, 1977).

The present paper will present a Decision Support System that is able to include these elements of uncertainty and heterogeneity. In particular, our Decision Support System originates from the housing location choice theory proposed by McFadden in the 1990s, assuming an extension of the neoclassical economic model to simulate consumer choice behaviour. Assuming the classical model of a rational utility maximizing consumer, it is assumed that the utility function itself is not known in advance by the analyst (see McFadden, 1977). Based on this assumption, the perceived utility U_{ij} can be expressed as the sum of two specific components: an ordinal utility component, and a random residual. The ordinal utility is the average of the expected value of the perceived utility among all users with the same choice context of decision *i.* The random residue ε_{ij} is the deviation from the perceived utility compared with the expected value for all effects of the various determinants that introduce uncertainty in the modelling choice. Indeed, in the real estate market there are substantial differences between the actors involved in a decision-making process, depending on the purposes of investment (final use, investment, safety, etc.), on the object of the investment, and on the strategic of the operator.

D'Alfonso (2007) has identified five categories of actors operating in the real estate market: real estate companies; small owners; management companies of real estate funds; users-owners; and tenants. Each of those classes of actors will, therefore, pursue different purposes for their investments, and therefore operate in a different sub-real-estate market (residential, commercial, industrial, handicraft, agricultural, etc.) and in a choice background or context characterized by different issues. When focussing our attention on the residential location choice problem, the variables of the choice model refer, on the one hand, to the specific class of actors (and thus to the attributes characterizing them), and, on the other, to the definition of a utility function for each investment destination. So, in this specific case, the rational subject is represented by users-owners and tenants and the alternatives of choice are represented by the geographical space (territory) in which the economic subject chooses to make the investment.

The areal utility function – or perceived attractiveness – is the capacity of a territory to attract investments in a specific relevant sub-market. Indeed, according to the hypothesis of rational decision making, an investor will choose the alternative (territory, or locality) which maximizes his utility function. Then the likelihood of choosing one territory rather than another will be determined by a number of attributes or characteristics of the territory itself which are able to achieve the objectives of the investor. Given the complexity that characterizes the individual territorial reality, the utility function will be a composed function, in which several attributes contribute to its definition, i.e. attributes relating to the economic, environmental, social, and institutional context, and to physical characteristics. In general, we assume, for the specific case under construction, a linear attractiveness function, without ignoring though, the possibility of using other specific functional forms of aggregation of the various attributes (Munda and Nardo, 2004).

In the next section, we present the methodology deployed to define an integrated model for the simulation of choice behaviour in the real estate market. In particular, we propose a novel integration of the Analytic Hierarchy Process (AHP) with a Stated Preference (SP) approach in order to evaluate and select the relevant attributes that enter the utility function.

3. The proposed methodology

3.1 Introduction

The present section presents an integrated methodology for defining a random utility model for real estate investments in relation to residential location choice. In particular, this paper focuses attention on the definition of attributes relevant for the calibration of the real estate choice model.

We offer here an integrated methodological approach where the use of two different methodologies contributes to the design of a Decision Support System (DSS) for residential location choice. This DSS has a dual objective: to support, on the one hand, the economic subject looking where to invest, and, on the other, for decision makers in a given territorial market activity, highlighting the factors that determine the attractiveness of a place. Based on the general assumptions of a discrete choice model, the proposed study is logically organized in four sequential steps (see Figure 1), each of which is characterized by different objectives, instruments and moments of analysis:

- A first step where a general list of attributes is identified on the basis of studies conducted in the international context;
- A second step where an assessment of relevant attributes is considered for the specific area examined (Municipality of Naples) by means of the Analytic Hierarchy Process (AHP);
- A third step where a Stated Preference (SP) experiment is carried out to evaluate different alternatives characterized by the relevant attributes assessed in the previous phase. The questionnaire is structured here by using a Fractional Factorial Design;
- A fourth and final step consists of the calibration of the coefficients of the choice model by the use of *a multinomial logit* model.

These steps of our methodology are described in greater detail in Subsections 3.2, 3.3 3.4 and 3.5 below.

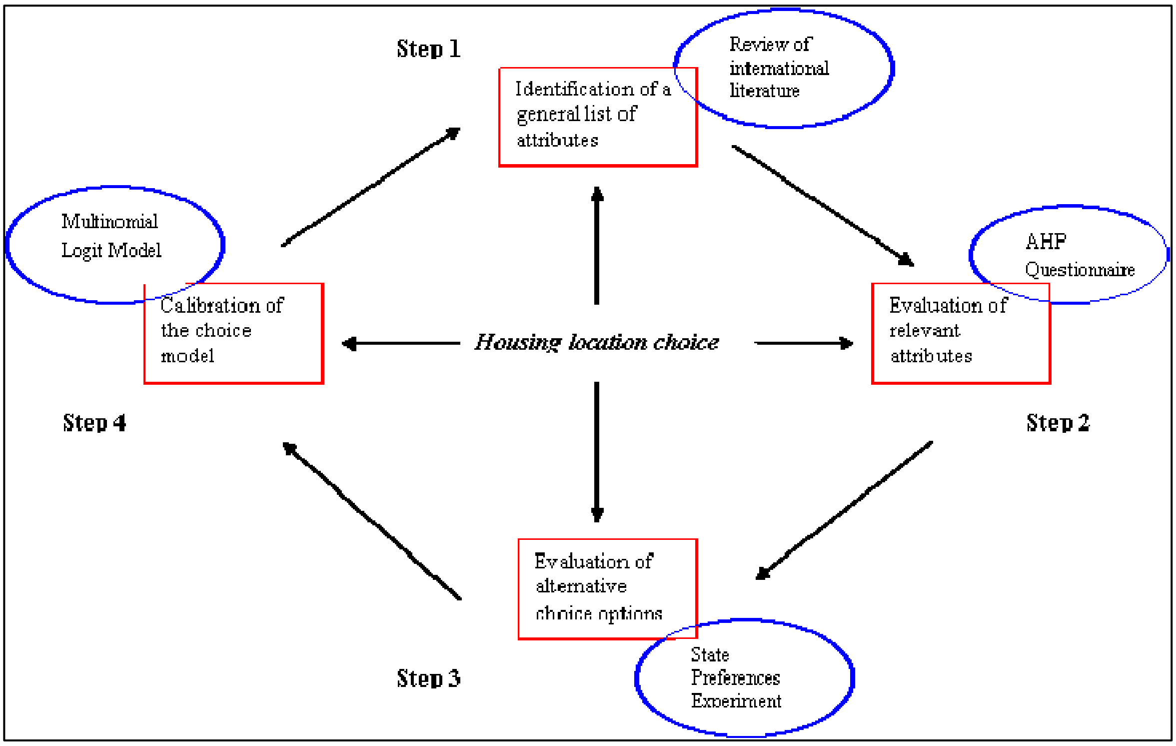

Figure 1. The integrated methodological approach

3.2 Step 1: the selection of attributes

In general, the attractiveness of a territory is defined as the capacity to attract, develop, and retain the resources and expertise that allow an area to compete and grow in a sustainable manner (Dubini, 2004). In the specific sector of the housing market, the capacity to attract investments is defined as the ability of a territory to offer a favourable environment for investors and users, that is able to attract individuals looking for places where they can locate their property investment or settle (Gabetti Holding Spa and Nomisma, 2005). The problem of housing choice is, therefore, strongly related to the identification of the factors associated with the dwelling and environmental context that may determine the attractiveness of a place. Numerous studies have been carried out in the international literature on housing choice models (see, e.g., Cooper et al., 2001; Earnhart, 2002; Gayda, 1998; Ortuzar et al., 2000; Perez et al., 2003; Walker et al., 2002), and a wide variety of explanatory variables has been considered: price, rent, dwelling size, accessibility, natural features, etc. (see for an illustrative overview Table 1).

Starting from the above-mentioned study, a general list of attributes is presented taking into account the specific context under investigation. In the definition of each attribute much attention is given to the 'perception' that decision makers have of the quality of places. A detailed description of the attributes is reported in Table 2.

In the next section the methodology to assess the relevant attributes for the specific context is presented.

Table 1. Examples of Stated Preference studies of the housing market

Author(s)	Date	Case study	Explained variable	Explanatory variables
Cooper et al.	2001	Belfast, UK	Housing choice	Density Price
Earnhart	2002	Fairfield, USA	Housing choice	Dwelling size Natural features Price
Gayda	1998	Brussel, Belgium	Housing choice	Travel time to work Neighbourhood type Housing price
Ortuzar et al.	2000	Santiago, Chile	Housing choice	Accessibility Location
Perez et al.	2003	Santiago, Chile	Housing choice	Rent
Walker et al.	2002	West Midlands, North London, UK	Intention to move	Rent Travel time to work Travel time to education
Wang & Li	2004	Beijing, PRC	Housing choice	Dwelling attributes Area Rent Neighbourhood attributes
Kim et al.	2005	Oxfordshire, UK	Housing choice Intention to move	House price Travel time to work Travel cost to work Population density Travel cost to shop School quality
Bravi & Giaccaria	2006	Torino, Italy	Location choice	Location Typology Price Pollution Subway line
Rosato et al.	2008	Venezia, Italy	Investment choice	Location Allowable use Access Property regime Presence of conservation restriction Cost per square metre

Source: Kim et al. (2005)

Table 2. General list of dwelling attributes

Macro-attributes	Attributes	Description of attributes
Characteristics of building	Price	Current market value expressed in euros /m^2
	Dwelling size	Qualitative parameter defined on 5 classes ▪ Small: up to $45m^2$ ▪ Middle small: from 45 to $70m^2$ ▪ Middle: from 70 to $120m^2$ ▪ Middle great: from sqm. 120 to $150m^2$ ▪ Great: over $150m^2$
	Conservation state	Qualitative parameter that indicates the level of degradation related to the maintenance project to be carried out Low: restructuring construction Middle: extraordinary maintenance High: routine maintenance
	Style	Presence of decorative elements with historical, artistic or architectural quality
	Environment	Environmental characteristics of real estate (panoramic view, presence of green garden, sunny aspects) expressed using a nominal scale (high, medium, low)
Characteristics of context	Accessibility	Qualitative parameter expressed on the basis of a series of indicators: ▪ Proximity to services ▪ Proximity to the workplace ▪ Proximity to schools ▪ Proximity to highways, ports and airports ▪ Quality of public service The value of the indicator is expressed according to a qualitative scale (high, medium, low) defined in relation to the perception of the respondents concerning their access to the territory where they belong
	Social and Economic Context	Qualitative parameter defined on the perception of the social and economic context, expressed on the basis of a series of indicators: ▪ Safety ▪ Index of allocation of cultural-recreational structures ▪ Index of equipment of education facilities ▪ Index of equipment of health facilities ▪ Index of social infrastructure endowment ▪ Quality of life/liveability The value of the indicator is expressed on a qualitative nominal scale(high, medium, low)
	Environmental Quality	Qualitative parameter linked to the perception of environmental quality in relation to the level of pollution, the presence of public green areas, the presence of parks, etc. The value of the indicator is expressed on a qualitative nominal scale(high, medium, low)
	Belonging	Qualitative parameter that aims to represent a sense of belonging to a place associated with the identity of the place

3.3 Step 2: the assessment of relevant attributes

The methodology proposed for the evaluation of relevant attributes is based on the Analytic Hierarchy Process (AHP) developed by T.L. Saaty in the 1970s (see for an overview Saaty, 2001). Starting from a general list of attributes (see Table 2) a questionnaire was presented to a selected number of experts from the Departments of the Faculty of Engineering at the University of Naples 'Federico II', in order to identify those elements that most likely influence the housing choice in the context of the Naples Metropolitan area. The questionnaire, according to the AHP logic, requires respondents to express a nominal preference for the attributes selected through pair-wise comparisons. The results obtained from each individual questionnaire, represent the weights and therefore the importance associated to each attribute. These weights were then aggregated by means of the Aggregating of Individual Priorities (AIP) technique in order to obtain the total weights of attributes.

In a decision-making process there are various ways to aggregate information in the presence of many decision makers. In the literature two ways are advocated in particular (Forman and Peniwati, 1998), namely:

- Aggregation of Individual Judgments (AIJ): consisting of aggregating individual judgments for each set of pair-wise comparisons, in an aggregate hierarchy;
- Aggregating of Individual Priorities (AIP): consisting of synthesizing each individual hierarchy and the resulting aggregate priorities, in order to reach the rational choice of the group from individual choices.

In this study we chose to proceed by following the second mode (AIP), as the concept of a 'group' in the AIP mode is more in agreement with our case study: the AIJ considers the group of decision makers as a single entity, while the AIP sees it as a set of separate individuals. In the first case, the group behaves as if it were a single individual: individual identities are lost at every stage of aggregation and the result expresses the priorities of the group. In the second case, however, it is assumed that the various decision makers have different influences on the final choice, and therefore, it is important to take into account a different system of values. This approach seems more appropriate for the case being considered. The aggregation function used is the geometric mean that meets the conditions underlying the method (Saaty, 2001).

The proposed questionnaire was compiled on the basis of expert opinion and with reference to guidelines prepared by the NOAA (National Oceanic and Atmospheric Administration) panel, in order to obtain an effective and appropriate tool for measuring the necessary information to be collected. This is because the questionnaire is, in fact, a tool for communication and, as such, its main objective is to transfer the information to the respondent as clearly as possible. On the other hand, it also represents a measuring instrument, whose function it is to collect and digest data and information on the attributes under investigation.

The questionnaires collected were divided into three groups based on the age and the social and economic characteristics of the respondents.

The first group in our sample of interviewees (GR1) includes those aged 20 to 35, mainly tenants or residents in the family home; the second group (GR2) includes those aged 35 to 50, owners or tenants, and the third group (GR3) includes those aged 50 to 65, again owners or tenants. Table 3 shows the estimated weights as ordinal rankings for each group.

Table 3. Weights for groups of respondents

		Mean 20-35 GR1	**Rank GR1**	**Mean 35-50 GR2**	**Rank GR2**	**Mean 50-65 GR3**	**Rank GR3**
Macro-attributes	Characteristics of real estate	0.193	**2**	0.185	**2**	0.194	***2***
	Characteristics of context	0.730	**1**	0.811	**1**	0.618	***1***
Attributes	Price	0.130	**3**	0.239	**1**	0.067	***6***
	Dwelling size	0.140	**2**	0.118	**4**	0.137	***3***
	Conservation state	0.126	**4**	0.098	**5**	0.100	***4***
	Style	0.053	**6**	0.036	**6**	0.085	***5***
	Environment	0.281	**1**	0.179	**3**	0.418	***1***
	Presence of parking	0.086	**5**	0.229	**2**	0.180	***2***
	Accessibility	0.142	**3**	0.215	**3**	0.113	***3***
	Socio-economic context	0.182	**2**	0.410	**1**	0.252	***2***
	Environmental quality	0.275	**1**	0.225	**2**	0.441	***1***
	Sense of belonging	0.117	**4**	0.047	**4**	0.094	***4***

The weight assessed for each of the three rankings has next been aggregated through the AIP methodology in order to define the aggregate set of weights. The results are shown in Table 4.

Table 4. Aggregate weights for entire group

		Mean	**Rank**
Macro Attributes	Characteristics of real estate	0.194012	**2**
	Characteristics of context	0.717908	**1**
Attributes	Price	0.129999	**4**
	Dwelling size	0.133930	**3**
	Conservation state	0.109773	**5**
	Style	0.056238	**6**
	Environment	0.279639	**1**
	Presence of parking	0.155290	**2**
	Accessibility	0.153775	**3**
	Socio-economic context	0.269308	**2**
	Environmental quality	0.304988	**1**
	Sense of belonging	0.082376	**4**

The results reported in Table 4 show that the contextual characteristics have the greatest importance in the residential location choice, confirming also the assumptions underlying the study. Looking at the attributes we can make the following observations.

1. As regards the building characteristics, the variables that have the greatest influence on real estate choice are the environment, the presence of parking, and the dwelling size. This result is strongly confirmed by the dynamics of the local real estate market. In fact, considering the market value as a budget constraint, the most significant variables are likely to reflect the main characteristics and problems of the metropolitan area of Naples. The particularities of the urban landscapes favour the choice of buildings characterized by panoramic views or positive environmental characteristics, just as the problem of traffic and parking spaces favours buildings where there is opportunity for parking.
2. As regards the characteristics of the urban context, the attributes related to environmental issues and the socio-economic context have a preponderant weight, and this result is a factor also reflected in the local market.

On the basis of the results obtained, we chose to focus our analysis and definition of the SP survey only on the contextual variables, in order to understand how environmental quality, the socio-economic context, and accessibility do influence the residence location choice.

The need to focus our attention on a relatively small number of attributes comes from the experimental SP design. In fact, there is evidence that an economic actor does not choose an alternative good itself, but considers the attributes that characterize it, and hence the change in the levels of attributes (as is witnessed in multi-attribute utility theory; see e.g., Lancaster, 1996). So, the greater the number of attributes on which the choice is based, the more difficult it is for the decision maker to make a conscious comparison with the alternative proposed.

The next section concerns now the description and implementation of the SP experiment for the assessment of different choice location options characterized by different attributes.

3.4 Step 3: Stated Preference (SP) experimental design

The implementation phase of an SP survey is one of the most sensitive stages of the analysis, because its objective is to induce those interviewed to express their preferences with respect to a set of alternative scenarios.

In an SP experiment, respondents are offered hypothetical alternatives in order to evaluate and to express their preference for the alternatives in various ways. The SP approach has a number of advantages compared with Revealed Preference methods. It can avoid correlation problems, ensure sufficient variation in data, offer a better trade-off between variables than often exists in the real world, collect multiple choices per person, and avoid measurement errors in the independent variable. Each alternative presented to the respondents is characterized by a set of relevant attributes. The levels or values associated with each attribute must be realistic and are usually combined according to the rules of an experimental design procedure so as to permit trade-offs between attributes (Wang and Li, 2004; Kim et al., 2003, 2005; Walker et al., 2002; Earnhart, 2002; Louviere et al., 2000).

An SP experiment consists of a number of elements: the composition of the choice contexts proposed to the decision maker/interviewee, the selection of the choice context proposed, the type of preference response elicited from the decision maker; and the way in which the interview is conducted (Cascetta, 2006).

There is a logical sequence of tasks required to design an SP choice experiment, as indicated by Louviere et al. (2000), Hensher (1994) and Pearmain et al. (1991). Firstly, we must identify and select the attributes to be included in the choice experiment. Walker et al. (2002) suggest not considering more than five attributes in each scenario, in order to make the choice as clear as possible for the interviewee. Secondly, it is necessary to identify for each attribute a unit of measurement that is not always uniquely determined. After establishing the scales for measuring the attributes, we must then define the levels of each attribute, and finally proceed to build and structure the choice experiment.

The choice experiment can be appropriately structured by using a Full Factorial Design, which considers all possible combinations of attributes and their levels. In most cases, the number of theoretically possible scenarios is very high, because splitting n factors, k groups ($i = 1, 2 ,..., k$), and n_i elements taking m levels, the total number of scenarios will be:

$$N = \prod_{i=1}^{k} m_i^{n_i}$$

There are various techniques to reduce the number of scenarios generated by a Full Factorial Design, one of these is a Fractional Factorial Design, which allows just a subset of the scenarios to be used permitting orthogonal estimation, that is usually constructed to eliminate main-effect correlation between attributes. By following the logical sequence mentioned above, an SP experiment was defined by deploying the attributes selected in the previous step. For each of them a measurement unit was identified and its corresponding levels (see Table 5).

More specifically, accessibility is measured in terms of total time taken for a single trip (in minutes, using the intervals: +5 minutes; +15 minutes; +30 minutes) from the house to main urban services; regarding the environmental quality, we consider the presence of green spaces on the basis of a qualitative measure, and, finally, the socio-economic context is expressed on a qualitative scale which measures the perceived level of safety.

Using an ordinal scale consisting of 9 levels, three distinct classes' levels for each environmental and socio-economic attribute can be defined: high (7-9), medium (4-6), and low (1-3).

Table 5. Definition of attributes and levels

Attribute	Description (measurement units)	Level
Accessibility	Access time from house to the main services and urban infrastructure: in minutes	+5 minutes +15 minutes +30 minutes
Environmental quality	Presence of green areas: High = 7-9 Medium = 4-6 Low = 1-3	High Medium Low
Socio-economic context	Safety: High = 7-9 Medium = 4-6 Low = 1-3	High Medium Low

The alternative choice options are hypothetical housing locations and, therefore, in order to relate the investigation to a real context[2], reference was made to some districts of the city of Naples, derived from information provided by the FIAIP (the Italian Federation of Professional Real Estate Agents). Since we consider three alternatives characterized by three attributes, each of which has three levels, a Full Factorial Design would provide a choice experiment consisting of 27 alternative scenarios. However, it is very difficult to administer a questionnaire which consists of 27 different alternative scenarios. And therefore, we had to

[2] Regarding the realism of the scenarios, it is noteworthy the results of SP surveys are significantly better if they concern choices directly related to the knowledge and direct experience of the decision maker/interviewee (Cascetta, 2006).

reduce the number of scenarios through a Fractional Factorial Design according to the methodology proposed in the '*Catalogue of Computer Programs for the Design and Analysis of Orthogonal Symmetric and Asymmetric Fractional Factorial Experiment'* (Kocur et al., 1982). So we reduced the number of scenarios from 27 to 9, taking into account the orthogonal estimation of the main effects and denoted interactions; in other words, all estimates of effects obtained from the design are uncorrelated.

This analysis led us to consider 9 hypothetical scenarios each characterized by different levels of the three attributes defined in table 5. The master plan of the scenarios proposed in the questionnaire is reported in Appendix 1.

Also at this stage, the questionnaire was compiled in accordance with the guidelines of the NOAA (National Oceanic and Atmospheric Administration) Panel. In particular, this questionnaire was subdivided into three distinct parts, namely:

1) Introductory section:
   - Brief description of the objectives;
   - Aptitude questions;
   - Questions on attributes;
   - Questions on lifestyle.
2) Evaluation section:
   - Description of the scenarios;
   - Preferences for scenarios (for preferred choice options);
3) Final section:
   - Questions on the socio-economic characteristics of the respondent.

The questionnaire was again presented to a selected number of experts from some of the Departments of the Faculty of Engineering at the University of Naples as a pre-test for its final design. The information obtained showed, amongst other things, some important considerations, such as:

- The respondents had low propensity or ability to imagine a hypothetical scenario. Therefore, it appeared appropriate to increase the level of detail in the description of the choice context;
- Despite having used a Fractional Factorial Design for reducing the number of scenarios and questions, the questionnaire was still too demanding for the interviewees.
- Some suggestions were made concerning the choice of attributes and the unit of measurement used.

The collected data and information were then analysed through a multinomial logit model. The results are reported in the next section.

3.5 The multinomial logit model

The multinomial logit model represents, nowadays, one of the most widely used random utility models. Those models are based on the assumptions that the random residuals are all independently and identically distributed (i.i.d.) according to a random Gumbel variable with mean equal to zero and parameter θ, i.e., $\theta_{i,}$ different from zero and equal to $\frac{\pi^2 \cdot \theta^2}{6}$ and where for $j \neq i$, $\theta_{i,j}$ be equal to zero (independent alternatives hypothesis), considering the matrix variance/covariance being a diagonal matrix

Through these assumptions it can be demonstrated that the probability function in choosing option *J*, of the set $I_{i,}$ composed of *n* alternatives, is equal to:

$$p(j) = \frac{\exp(U_i/\theta)}{\sum_{i=1}^{n} \exp\left(U_j/\theta\right)}$$

For ease of reference, the preliminary results related to the application and fine tuning of the model of selection of the residency are shown in Table 6. The variables examined have already been identified and evaluated in the prior phases of this analysis (see Table 5). From a statistical perspective, the fine tuning of the logit model needed to determine the utility function has been carried out through the Software BIOGEME 1.6 (Bierlaire, 2007).

Variable	value β	Std. Dev	t-statistic	p- value
Accessibility	0.0426	0.0389	1.10	0.27
Environmental Quality	0.148	0.0394	3.77	0.00
Social and economic background	-0.147	0.0216	-6.82	0.00

Table 6: Model calibration and statistic test

Although Table 6 offers a preliminary analysis, its results are consistent with the prior expectations. In fact, the variable “accessibility” and “environmental quality” incorporated under utility terms are positive and have a significant statistical meaning. Likewise, the variable “Social and economic background”, included under dis-utility terms, has a negative sign and also has a significant statistical meaning.

The results obtained confirm the assumptions on which the model is based and the dynamics of local markets, where the perceived low environmental quality and of social decay are characteristic of the urban context examined and strongly affect the selection of the place of residence and hence the location of investment in the sector. Even though the survey at hand is a first application on a limited sample of interviewed people, the results obtained seems favourable and confirm the validity of the approach used.

4. Conclusions and Further Development

This study represents the first step of a research project to develop a random utility model for the location of real estate investments. The positive results obtained, in particular the selected variables in the case of housing choice, are representative of categories of small owners and tenants. The SP survey conducted was a preliminary pilot study conducted in order to finalize the questionnaire for the assessment of alternative choice. The choice of attributes appears consistent with the dynamics of the local real estate market in which the analysis was carried out. The approach used is appropriate to determine the elements of perception that characterize the problem. In addition, the SP helped us to select, by means of a Fractorial Factorial Design, the scenarios to be evaluated and enabled us to gather useful information for the final version of the questionnaire in future experiments.

The next step of the work will be to administer the final questionnaire (developed after the SP study), to a sufficiently broad sample of respondents[3]. The choice model will then be calibrated on the basis of a multinomial logit model for the definition of the coefficients of the variables. On the basis of an extended multinomial logit model, we can then also derive a measure of the likelihood of choosing the various investment alternatives of investment, with reference to the different scenarios proposed, assuming independent alternatives for the choice options.

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[3] The minimum sample size varies from a minimum of 150 to a maximum of 1200 interviews.

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